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# GRADE 12 DIPLOMA EXAMINATION

Physics 30

January 1988

**Alberta**  
EDUCATION

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**GRADE 12 DIPLOMA EXAMINATION  
PHYSICS 30**

**DESCRIPTION**

Time: 2½ hours

Total possible marks: 70

This is a **CLOSED-BOOK** examination consisting of two parts:

PART A: 56 multiple-choice questions each with a value of 1 mark.

PART B: Three written-response questions for a total of 14 marks.

A physics data booklet is provided for your reference. Approved calculators may be used.

**GENERAL INSTRUCTIONS**

Fill in the information on the answer sheet as directed by the examiner.

For multiple-choice questions, read each carefully and decide which of the choices BEST completes the statement or answers the question. Locate that question number on the answer sheet and fill in the space that corresponds to your choice. **USE AN HB PENCIL ONLY.**

**Example**

**Answer Sheet**

This examination is for the subject area of

A    B    C    D

A. Chemistry

①    ②    ●    ④

B. Biology

C. Physics

D. Mathematics

If you wish to change an answer, please erase your first mark completely.

For written-response questions, read each carefully, show all your calculations, and write your answer in the space provided in the examination booklet.

NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.

**DO NOT FOLD EITHER THE ANSWER SHEET OR THE EXAMINATION BOOKLET**

The presiding examiner will collect the answer sheet and examination booklet for transmission to Alberta Education.

**JANUARY 1988**

THE CONSTITUTION

Article I

Section 1

ALL legislative Powers herein granted shall be vested in a Congress of the United States, which shall consist of a Senate and House of Representatives.

SECTION 2. The House of Representatives shall be composed of Members chosen every second Year by the People of the several States, and the Electors in each State shall have the Qualifications requisite for Electors of the most numerous Branch of the State Legislature.

NO Person shall be Representative of the People in any State, who was not, when elected, seven Years of Age, and seven Years a Citizen of the United States, and who, when elected, was seven Years a Citizen of that State.

Representatives and electors in each State shall have the Qualifications requisite for Electors of the most numerous Branch of the State Legislature.

### ARTICLE II

Section 1

The executive Power shall be vested in a President of the United States. He shall hold Office, for four Years; and, together with the Vice President, chosen for the same Term, shall be elected, in the following Manner:—

Section 2

Section 3

Section 4

Section 5

Section 6

Section 7

Section 8

Section 9

Section 10

Section 11

Section 12

Section 13

Section 14

Section 15

Section 16

## **PART A**

### **INSTRUCTIONS**

There are 56 multiple-choice questions with a value of one mark each in this section of the examination. Use the separate answer sheet provided and follow the specific instructions given.

**NOTE:** The perforated pages at the back of this booklet may be torn out and used for your rough work.

**WHEN YOU HAVE COMPLETED PART A, PROCEED DIRECTLY TO PART B**

**DO NOT TURN THE PAGE TO START THE EXAMINATION UNTIL TOLD  
TO DO SO BY THE PRESIDING EXAMINER**

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1. A ray of visible light passes from air into glass and undergoes a change in its
  - A. frequency and speed
  - B. wavelength and speed
  - C. wavelength and frequency
  - D. frequency, wavelength, and speed
  
2. The speed of light in a medium that has an index of refraction of 1.20 is
  - A.  $2.78 \times 10^8$  m/s
  - B.  $2.50 \times 10^8$  m/s
  - C.  $4.00 \times 10^7$  m/s
  - D.  $3.60 \times 10^7$  m/s
  
3. The first calculations that gave an estimate of the speed of light used measurements of the
  - A. light transmitted through a rotating toothed wheel
  - B. time required for light to travel across the Earth's orbit
  - C. divergence of a ray of light reflected off a rotating mirror
  - D. time delay between flashes of light from two lanterns on separate hills
  
4. On the basis of Fresnel's wave theory, Poisson predicted that
  - A. light consists of longitudinal waves
  - B. there should be patterns of light and dark when light passes through a narrow slit
  - C. there should be a bright spot in the centre of a shadow cast by a small, opaque, circular obstacle
  - D. light passing through a prism would be refracted to varying degrees, dependent on its wavelength
  
5. Which of these phenomena of light can be accounted for only by the wave theory of light?
  - A. Reflection
  - B. Interference
  - C. Emission spectra
  - D. Propagation through a medium

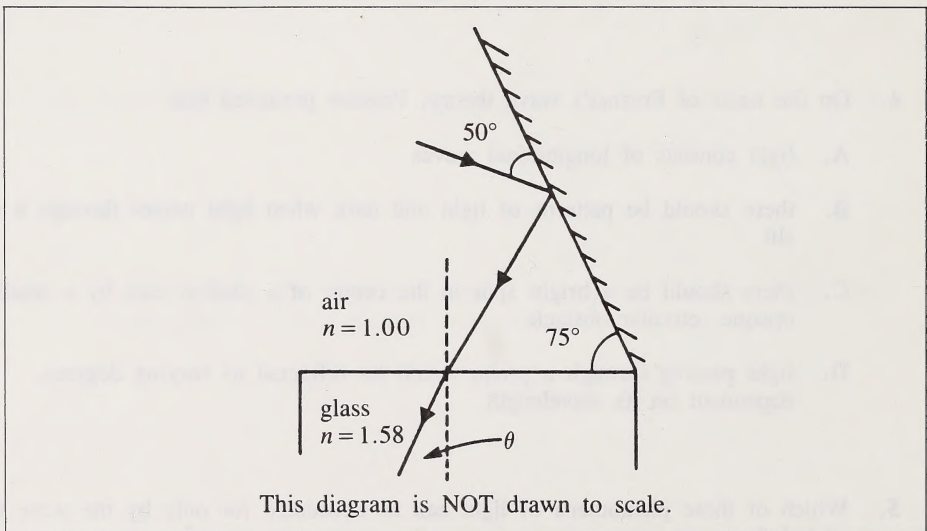
Use the following information to answer question 6.

These are some hypotheses concerning the behavior of light travelling from air to water:

- I. The angle of incidence is equal to the angle of refraction when the angle of incidence is zero.
- II. The speed of the wave decreases.
- III. The ratio of the respective speeds is equal to the ratio of the angle of incidence to the angle of refraction.
- IV. The ratio of the respective speeds is equal to the ratio of the sine of the angle of incidence to the sine of the angle of refraction.

6. According to the wave model of light, the hypotheses which describe what is most likely to happen when light travels from air into water are
- A. II and III only
  - B. II and IV only
  - C. I, II, and IV
  - D. II, III, and IV

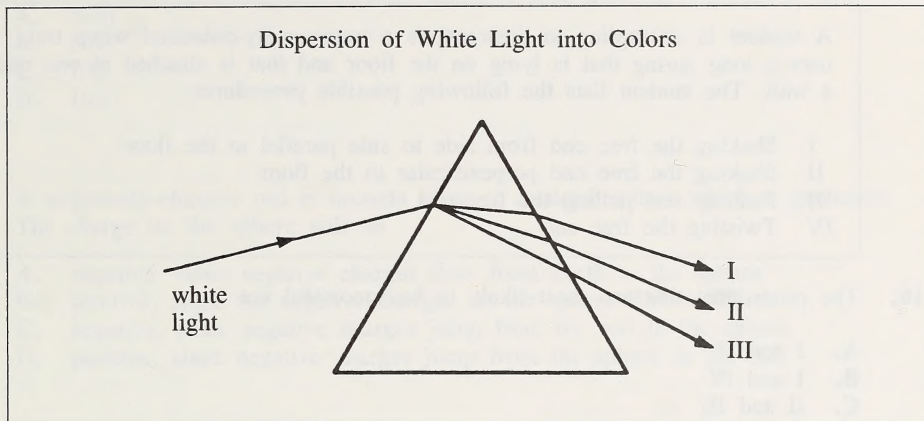
Use the following information to answer question 7.



7. An incident ray is first reflected and then refracted. The value of  $\theta$  is
- A.  $35^\circ$
  - B.  $21^\circ$
  - C.  $15^\circ$
  - D.  $9^\circ$



Use the following information to answer question 8.



8. The colors of rays I, II, and III respectively are most likely to be
- A. red, green, blue
  - B. red, violet, blue
  - C. blue, yellow, red
  - D. violet, green, blue
- 
9. A student uses the following experimental design to investigate interference. An air wedge is created between two flat glass plates by placing one of the plates on top of the other and placing a thin wire between the two at one end. When the wedge is illuminated with a monochromatic light, the student sees straight-line interference patterns. If, in a subsequent experiment, the air wedge is filled with water, the interference fringes will probably
- A. not occur
  - B. form in arcs
  - C. be farther apart
  - D. be closer together

Use the following information to answer question 10.

A student is attempting to demonstrate a transversely-polarized wave train. He uses a long spring that is lying on the floor and that is attached at one end to a wall. The student lists the following possible procedures:

- I Shaking the free end from side to side parallel to the floor
- II Shaking the free end perpendicular to the floor
- III Pushing and pulling the free end
- IV Twisting the free end

10. The procedures that are most likely to be successful are

- A. I and II
  - B. I and IV
  - C. II and III
  - D. II and IV
- 

11. A clear sky appears blue because the atmosphere

- A. absorbs blue light more than red light
- B. scatters blue light more than red light
- C. absorbs all colors of light except blue
- D. scatters all colors of light except blue

12. The statement that the net amount of charge in a closed system is constant is an expression of the law of conservation of

- A. charge
- B. energy
- C. mass-energy
- D. electrostatic forces

13. If two charges of magnitudes  $3.0 \times 10^{-6} \text{ C}$  and  $8.0 \times 10^{-4} \text{ C}$  attract with a force of  $2.4 \times 10^4 \text{ N}$ , then the separation of the two charges is

- A.  $4.5 \times 10^{-2} \text{ m}$
- B.  $3.0 \times 10^{-2} \text{ m}$
- C.  $9.0 \times 10^{-4} \text{ m}$
- D.  $3.2 \times 10^{-6} \text{ m}$

14. Electric field intensity can be expressed in units of
- A. N/m
  - B. N/C
  - C. J/C
  - D. J/m
15. A negatively-charged rod is brought close to a metal sphere which is grounded. The charge on the sphere will be
- A. negative, since negative charges flow from Earth to the sphere
  - B. positive, since the negative charges on the sphere flow to Earth
  - C. negative, since negative charges jump from the rod to the sphere
  - D. positive, since negative charges jump from the sphere to the rod

Use the following information to answer question 16.

Unit Combinations	
I	$J/(A \cdot s)$
II	$N/(A \cdot m)$
III	$(V \cdot m)/s^2$
IV	$(N \cdot s)/(C \cdot m)$

16. Magnetic field strength can be expressed in units of
- A. I and III
  - B. I and IV
  - C. II and III
  - D. II and IV
- 
17. The direction assigned to an electric field vector is the direction of the force exerted by the field on a
- A. positive test charge
  - B. negative test charge
  - C. flow of positive charge
  - D. flow of negative charge
18. Uranus has a mass of  $8.80 \times 10^{25}$  kg and a radius of  $2.67 \times 10^7$  m. What is the weight of a 30.0 kg space probe that has landed on the planet's surface?
- A.  $3.70 \times 10^{12}$  N
  - B.  $6.60 \times 10^9$  N
  - C.  $8.23 \times 10^2$  N
  - D.  $2.47 \times 10^2$  N



19. A charged metal sphere is near an identical sphere that has an opposite charge three times as large. If the spheres are touched together and are then returned to their original separation, the force between the two spheres will be
- A. repulsive and the same magnitude as the original force between the two spheres
  - B. attractive and twice the magnitude of the original force between the two spheres
  - C. repulsive and one-third the magnitude of the original force between the two spheres
  - D. attractive and one-half the magnitude of the original force between the two spheres
20. The force on a positive charge of  $3.6 \times 10^{-3} \text{ C}$  at a point in an electric field is  $4.2 \times 10^{-4} \text{ N}$ . The magnitude of the electric field at that point is
- A.  $1.5 \times 10^{-12} \text{ V/m}$
  - B.  $1.2 \times 10^{-7} \text{ V/m}$
  - C.  $1.5 \times 10^{-6} \text{ V/m}$
  - D.  $1.2 \times 10^{-1} \text{ V/m}$
21. The electric field between two parallel plates that are 5.0 cm apart is  $1.0 \times 10^2 \text{ N/C}$ . The potential difference across the plates is
- A.  $2.0 \times 10^3 \text{ V}$
  - B.  $5.0 \times 10^2 \text{ V}$
  - C.  $2.0 \times 10^1 \text{ V}$
  - D.  $5.0 \times 10^0 \text{ V}$
22. The scientist who is acknowledged to have produced the first steady electric current is
- A. Volta
  - B. Oersted
  - C. Ampère
  - D. Franklin
23. It would be FALSE to state that the electric and gravitational fields surrounding small spherical objects
- A. are vector fields
  - B. involve a form of potential energy
  - C. vary inversely with the square of the distance
  - D. each exert both attractive and repulsive forces

Use the following information to answer question 24.

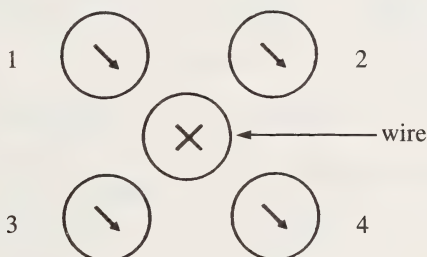
In a description of an experiment, the following paragraph was written.

An alpha particle and an electron, with equal kinetic energies, enter perpendicularly into a strong uniform magnetic field from the same direction. The particles are forced to move in opposite directions along parabolic paths with different curvatures.

24. The paragraph is in error because
- A. the paths of the particles cannot be parabolic
  - B. the curvature of the paths cannot be different
  - C. differently charged particles cannot be deflected by the same magnetic field
  - D. the kinetic energy of an electron cannot equal the kinetic energy of an alpha particle
- 

Use the following information to answer question 25.

A student uses compasses to investigate the magnetic field around a current-carrying wire. The position of the compasses before the current is switched on is shown in the diagram.



represents compasses at various positions around the conductor.

When the current is switched on, the electrons flow into the page.

25. After the current is switched on, the compass that does NOT change direction is numbered
- A. 1
  - B. 2
  - C. 3
  - D. 4
-

26. If a proton moves perpendicularly across a magnetic field of strength  $2.0 \times 10^{-2}$  T at a speed of  $5.0 \times 10^6$  m/s, it would experience a force of
- A.  $1.7 \times 10^{-22}$  N
  - B.  $1.7 \times 10^{-20}$  N
  - C.  $1.6 \times 10^{-14}$  N
  - D.  $1.6 \times 10^{-12}$  N

Use the following information to answer questions 27 and 28.

The magnitude of the magnetic field surrounding a current-carrying wire is given by the formula

$$B = k_m \frac{I}{r}$$

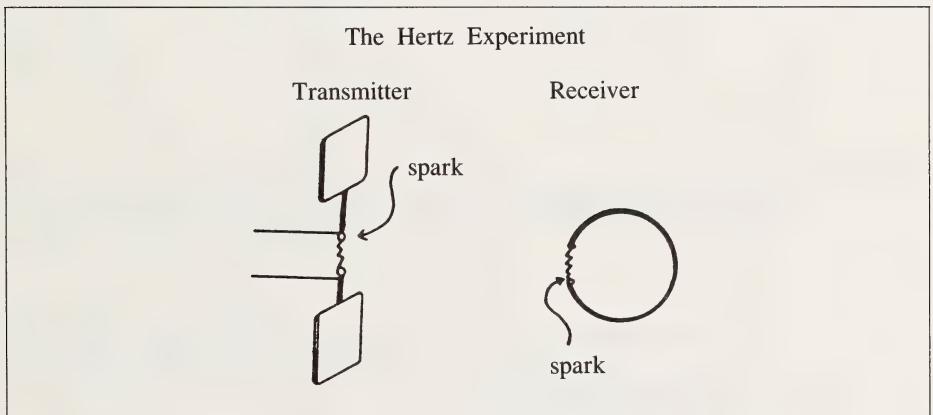
where  $k_m$  is a magnetic constant,  $I$  is the current in the wire, and  $r$  is the distance from the wire.

27. At a distance of 5.0 cm from a wire that carries a 3.0 A current, the magnetic field is  $1.2 \times 10^{-5}$  T. What is the numerical value of  $k_m$  in SI units?
- A.  $2.0 \times 10^{-7}$
  - B.  $1.2 \times 10^{-5}$
  - C.  $2.0 \times 10^{-5}$
  - D.  $7.2 \times 10^{-4}$
28. Appropriate SI units for  $k_m$  are
- A. N/A<sup>2</sup>
  - B. N/m<sup>2</sup>
  - C. T/A
  - D. N/(A•m)
- 
29. A current may be induced in a loop of wire if the loop is
- A. at rest in a magnetic field
  - B. moved perpendicular to an electric field
  - C. moved parallel to a uniform magnetic field
  - D. rotated about an axis perpendicular to a magnetic field



30. There will be NO electromagnetic radiation generated when
- A. a light is being switched on
  - B. a radio is being switched off
  - C. a direct current of 1.00 A exists in a copper wire
  - D. an alternating current of 1.00 A exists in a copper wire
31. The theoretical and experimental evidence that light is an electromagnetic wave was compiled by
- A. Römer and Young
  - B. Maxwell and Hertz
  - C. Gilbert and Coulomb
  - D. Huygens and Newton
32. In an electromagnetic wave, the electric field  $\vec{E}$  and the magnetic field  $B$  are
- A. perpendicular
  - B. parallel
  - C. constant
  - D. equal

Use the following information to answer question 33.

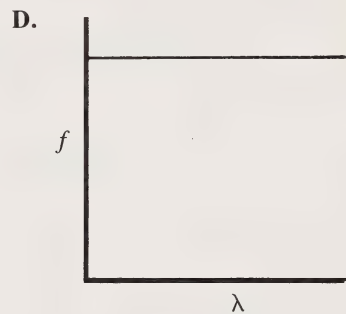
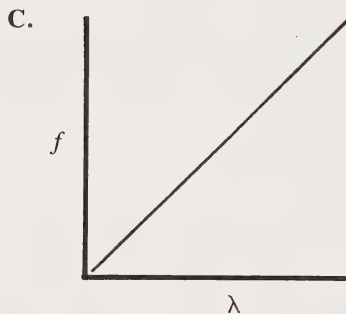
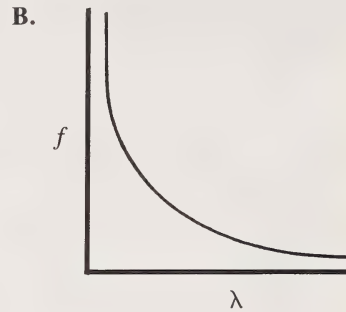
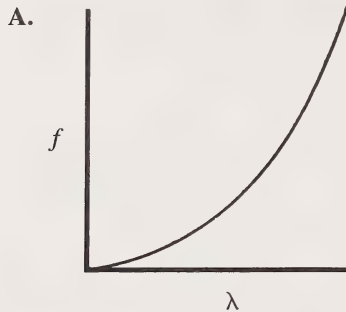


33. The induced spark in the receiving coil could be eliminated by
- A. rotating the plane of the receiving coil
  - B. reducing the spark gap in the receiving coil
  - C. reducing the spark gap in the transmitter coil
  - D. decreasing the distance between the transmitter and the receiving coil

34. An example of an electromagnetic radiation with a frequency less than that of visible light is

- A. X-ray
- B. gamma
- C. infra-red
- D. ultraviolet

35. Of the following graphs showing the relationship of frequency to wavelength, the one that is true for ALL forms of electromagnetic radiation is



36. As a result of the Michelson-Morley experiment, scientists decided that the

- A. ether hypothesis was supported
- B. ether hypothesis needed revision
- C. experimental design needed revision
- D. data from the experiment were inconclusive

Use the following information to answer question 37.

A student lists the properties of X-rays. The list shows that X-rays

1. can ionize hydrogen gas
2. travel with a speed of  $3.0 \times 10^8$  m/s in vacuum
3. can exert pressure
4. can penetrate flesh
5. have a frequency in the range  $1.0 \times 10^{17}$  Hz to  $1.0 \times 10^{22}$  Hz
6. can be polarized

37. Properties which are common to ALL forms of electromagnetic radiation are
- A. 2 and 3 only
  - B. 2 and 6 only
  - C. 1, 2, and 3 only
  - D. 2, 3, and 6 only
- 
38. In an electrolysis experiment, 40 L of gas were collected. In a second experiment using the same gas carried out under the same conditions of temperature and pressure but using exactly one-half the current for exactly four times as long, the amount of gas collected would be predicted to be
- A. 10 L
  - B. 20 L
  - C. 40 L
  - D. 80 L
39. The radius of curvature of the path of an ion with a charge of  $2e$  in a magnetic field of strength  $2.00 \times 10^{-2}$  T is 1.25 cm. If the speed of the ion is  $3.00 \times 10^3$  m/s, its mass is
- A.  $2.67 \times 10^{-26}$  kg
  - B.  $2.67 \times 10^{-24}$  kg
  - C.  $3.84 \times 10^{-14}$  kg
  - D.  $3.84 \times 10^{-12}$  kg



40. An alpha particle, when split into its individual nucleons, consists of

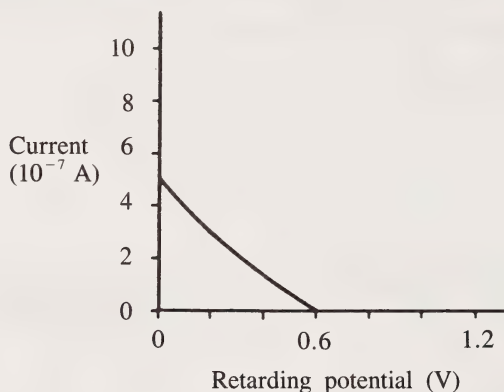
- A. one proton
- B. two protons
- C. one proton and one neutron
- D. two protons and two neutrons

41. Cathode rays can be shown to be

- A. charged particles because they are deflected by magnetic fields
- B. charged particles because they are not deflected by magnetic fields
- C. electromagnetic waves because they are deflected by magnetic fields
- D. electromagnetic waves because they are not deflected by magnetic fields

Use the following information to answer questions 42 and 43.

A series of experiments is designed to investigate the operation of the photoelectric light meter in a camera.



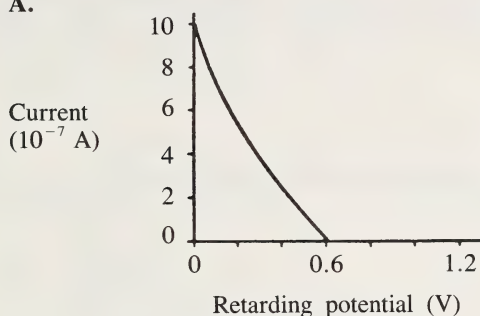
A variable-voltage power supply is used to retard the movement of electrons in a photocell. The graph shows the relationship between photoelectric current and retarding potential when the photocell is illuminated with green light.

42. The maximum kinetic energy of the photoelectrons is

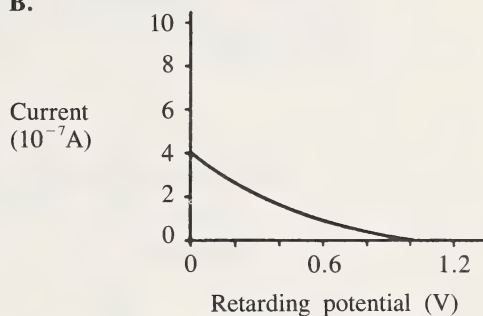
- A.  $6.0 \times 10^{-8}$  eV
- B.  $5.0 \times 10^{-7}$  eV
- C. 0.60 eV
- D. 5.0 eV

43. In a second experiment the green light is made brighter. The relation between photoelectric current and retarding voltage would be as shown in the graph labelled

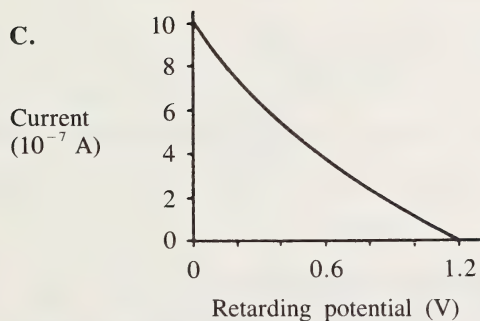
A.



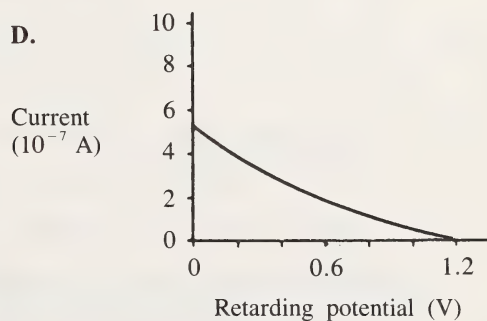
B.



C.



D.

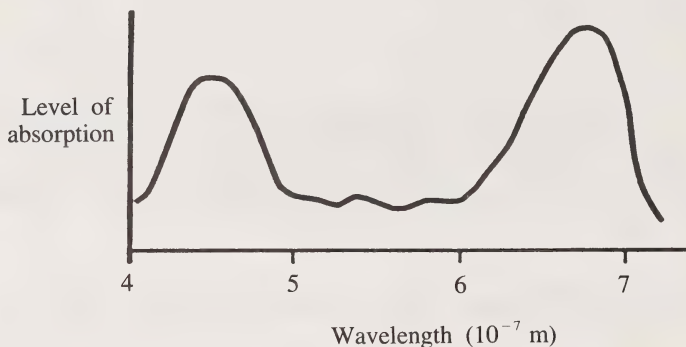


44. According to Maxwell's theory of electromagnetism, the planetary model for the hydrogen atom needed to be changed because the

- A. positive nucleus would explode
- B. proton would fly out of the atom
- C. electron would spiral into the nucleus
- D. nucleus and the electron would have a weak attraction for each other

Use the following information to answer question 45.

A student is investigating the effect of incident light color on plant growth. The initial experiment measures the energy absorption in a leaf tissue as a function of wavelength.



The graph shows the absorption of various colors of incident light by a green plant for photosynthesis.

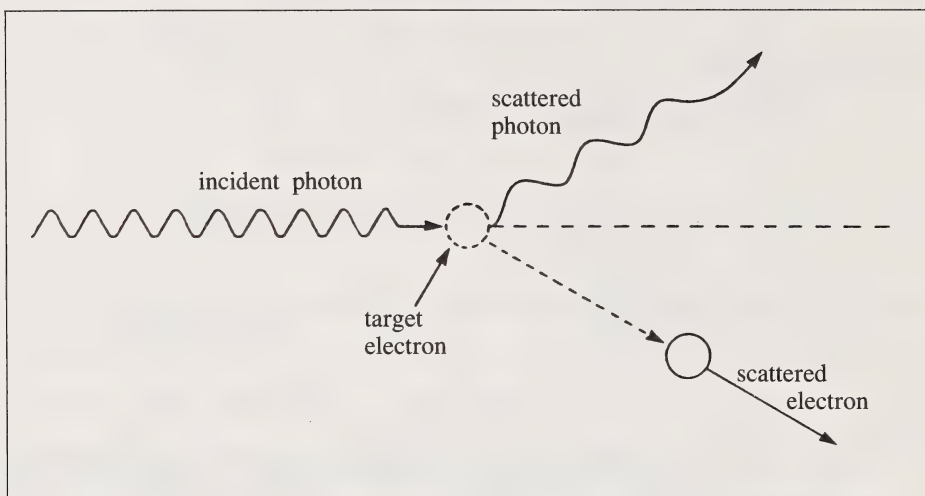
45. Using the graph, which inference can be made?
- A. Blue light is better for photosynthesis than red light.
  - B. Infra-red light is better for photosynthesis than visible light.
  - C. Light from outside of the visible spectrum is unusable for photosynthesis.
  - D. Green and yellow light are less effective than red light in activating photosynthesis reactions.
- 
46. When a photoelectric current is  $1.0 \times 10^{-7}$  A, the number of photoelectrons emitted each second is
- A.  $3.5 \times 10^6$
  - B.  $6.3 \times 10^{11}$
  - C.  $1.6 \times 10^{12}$
  - D.  $2.2 \times 10^{18}$
47. At what speed will the relativistic mass of an object be 10% greater than its rest mass?
- A.  $9.0 \times 10^9$  m/s
  - B.  $1.2 \times 10^8$  m/s
  - C.  $9.0 \times 10^6$  m/s
  - D.  $1.2 \times 10^6$  m/s



48. If an object has a mass of  $4.0 \times 10^{-17}$  kg when travelling at a speed of  $0.70c$ , its rest mass is
- A.  $2.0 \times 10^{-17}$  kg
  - B.  $2.9 \times 10^{-17}$  kg
  - C.  $5.6 \times 10^{-17}$  kg
  - D.  $7.8 \times 10^{-17}$  kg
49. A process that changes both the frequency and the wavelength of an electromagnetic wave is
- A. refraction
  - B. polarization
  - C. Compton scattering
  - D. double-slit interference
50. The momentum of a photon with  $5.1 \times 10^{-19}$  J of energy is
- A.  $8.6 \times 10^{-49}$  kg•m/s
  - B.  $2.6 \times 10^{-40}$  kg•m/s
  - C.  $1.7 \times 10^{-27}$  kg•m/s
  - D.  $1.3 \times 10^{-12}$  kg•m/s
51. In a nuclear fusion reaction, it was found that the total mass of the reactants was  $9.0 \times 10^{-3}$  kg. If the total mass of the fusion products was  $8.0 \times 10^{-3}$  kg, the energy released in the reaction was
- A.  $3.0 \times 10^{21}$  J
  - B.  $1.5 \times 10^{15}$  J
  - C.  $7.2 \times 10^{14}$  J
  - D.  $9.0 \times 10^{13}$  J
52. De Broglie's equation,  $\lambda = h/(mv)$ , predicts that the wavelength associated with a particle
- A. varies directly as the mass of the particle
  - B. varies inversely as the momentum of the particle
  - C. would be infinite if  $v$  was equal to the speed of light
  - D. would increase as the relativistic mass of a particle increases at very high speeds
53. Einstein was NOT satisfied with the quantum theory because the theory
- A. did not provide for a theory of gravity
  - B. did not incorporate his relativity theory
  - C. was deterministic and did not allow for free will
  - D. was too dependent on the mathematics of probabilities

54. What is the de Broglie wavelength of an electron that has been accelerated from rest through a potential difference of  $5.0 \times 10^1$  V?
- A.  $4.1 \times 10^{-15}$  m
  - B.  $5.7 \times 10^{-14}$  m
  - C.  $1.7 \times 10^{-10}$  m
  - D.  $7.2 \times 10^{-2}$  m

Use the following information to answer question 55.



55. The interaction illustrated in the diagram is known as
- A. X-ray diffraction
  - B. the Compton effect
  - C. Rutherford scattering
  - D. the photoelectric effect
- 
56. The model of an atom provided by quantum mechanics is
- A. non-existent
  - B. primarily physical
  - C. primarily mathematical
  - D. both physical and mathematical

**YOU HAVE NOW COMPLETED THE MULTIPLE-CHOICE SECTION OF THE EXAMINATION. PLEASE PROCEED TO THE NEXT PAGE AND ANSWER THE WRITTEN-RESPONSE QUESTIONS IN PART B.**

## **PART B**

### **INSTRUCTIONS**

Please write your answers in the examination booklet as neatly as possible.

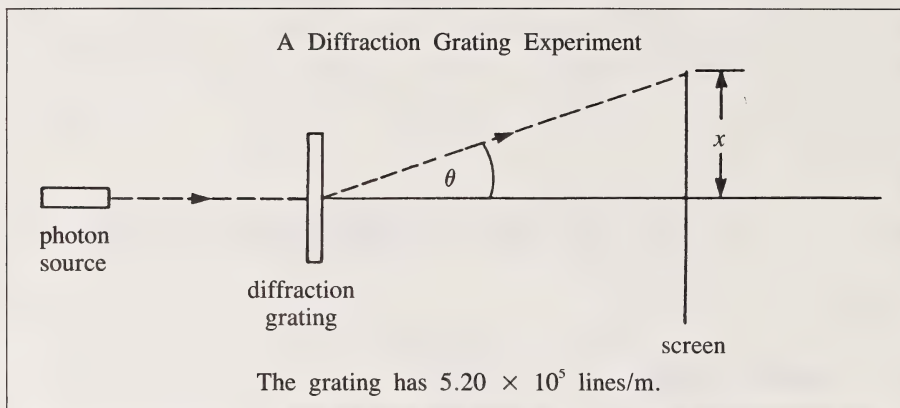
Marks will be awarded for pertinent explanations, calculations, formulas, and answers. Answers must be given to the appropriate number of significant digits.

<p>NOTE: The perforated pages at the back of this booklet may be torn out and used for your rough work.</p>
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**TOTAL MARKS: 14**

**START PART B IMMEDIATELY**

Use the following information to answer question 1.



(5 marks)

1. Photons with energy of 3.10 eV are passed through a diffraction grating with  $5.20 \times 10^5$  lines/m. The grating is located 80.0 cm from a screen. Calculate BOTH the distance  $x$  AND the diffraction angle  $\theta$  of the first-order image from the central bright line.



Use the following equation to answer question 2.

$$qV = \frac{1}{2}mv^2$$

2. a. State in words the principle used to derive the above equation.

(1 mark)

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- b. Describe a physical situation to which the equation could be applied.

(1 mark)

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- c. List two conditions where the use of the equation will give inaccurate predictions of the final velocity  $v_f$ .

(2 marks)

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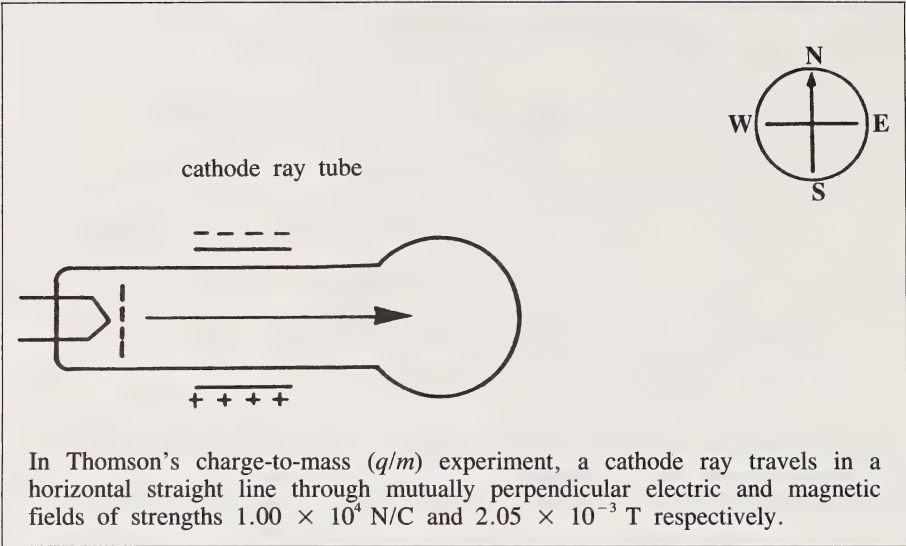
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Use the following information to answer question 3.



(2 marks)

3. a. Determine the speed of the cathode ray.

(1 mark)

b. If the cathode ray is directed from west to east and the electric field is directed from south to north, determine the direction of the magnetic field.

- c. If the charge-to-mass ratio for an electron is  $1.76 \times 10^{11}$  C/kg, determine the radius of curvature of the cathode ray in the magnetic field alone.

**(2 marks)**

**YOU HAVE NOW COMPLETED THE EXAMINATION. IF YOU HAVE TIME,  
YOU MAY WISH TO GO BACK AND CHECK YOUR ANSWERS.**





(NO MARKS WILL BE GIVEN FOR WORK DONE ON THIS PAGE)

FOLD AND TEAR ALONG PERFORATION



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